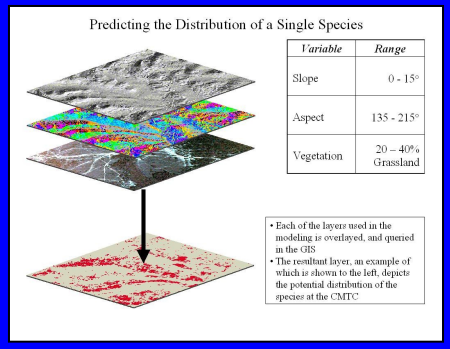
High-Resolution Vegetation Mapping Applications in USAREUR


Predicting the Distribution of a Single Species
Variable
Range
Slope
0 - 15°
Aspect
135 - 215°
Vegetation
20 – 40% Grassland
• Each of the layers used in the modeling is overlayed, and queried in the GIS
• The resultant layer, an example of which is shown to the left, depicts the potential distribution of the species at the CMTC

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Presentation Overview

- Introduction to Remote Sensing
- High resolution data acquisition
  - High resolution (0.16-0.5 meter) multispectral
  - High resolution (3-4 meter) hyperspectral
- Vegetation mapping
  - National Vegetation Classification System (NVCS) Formation Level
- Applications of the vegetation data

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Remote Sensing

- Definition
  - "Remote sensing is the science and art of gathering information about an object without coming into contact with it"
  - Can involve the sensing of energy emitted or reflected from objects in many different parts of the spectrum
- Issues of scale
  - Spatial Resolution
  - Spectral Resolution

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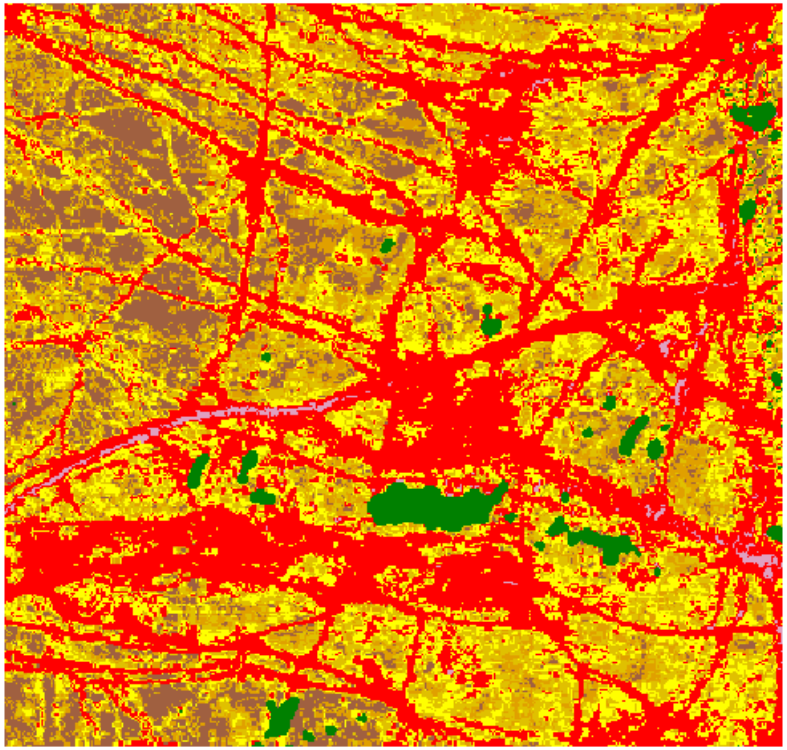
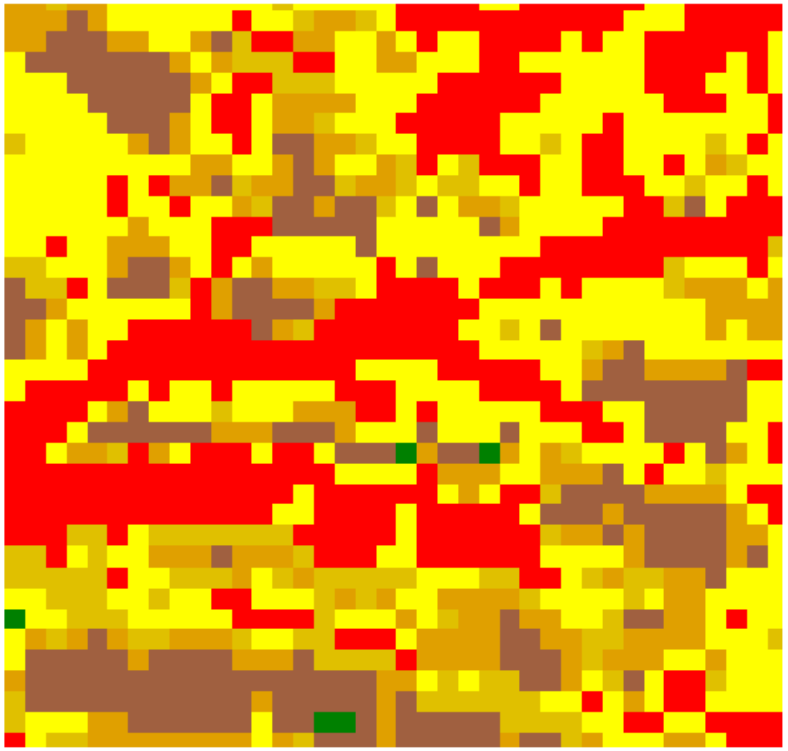
Spatial Resolution



2-meter resolution
landcover from MSS data



20-meter resolution
landcover from SPOT data

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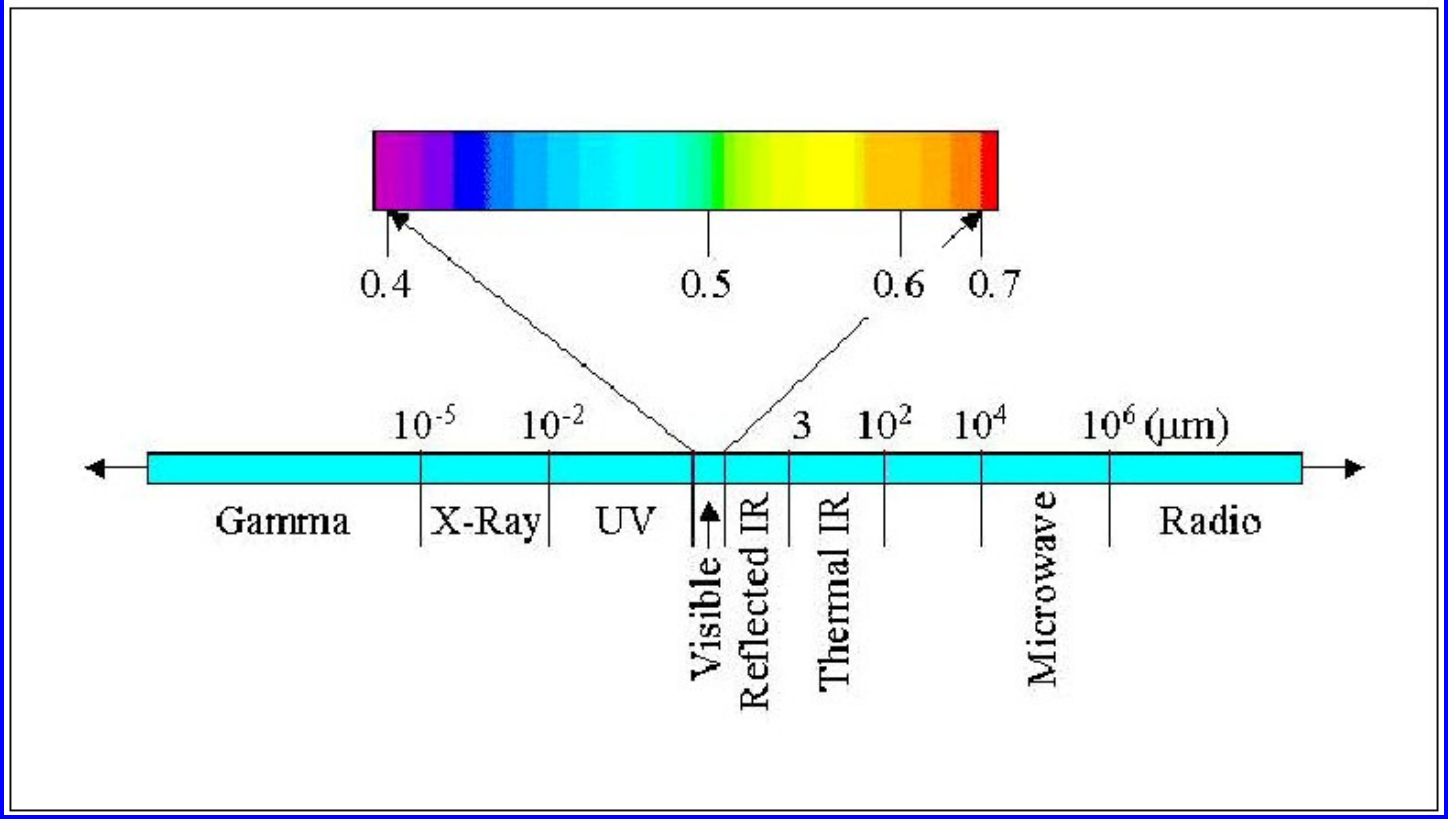
Spectral Resolution



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USAREUR Major Training Areas

- Friedberg Training Area
  - 8,779 acres
  - Largely forested with small open training area
- Grafenwoehr Training Area
  - 61,600 acres
  - Mixed forest, grasslands and shrublands
- Hohenfels Training Area
  - 40,000 acres
  - Approx. 50% forested, 50% open with very high species diversity (grasslands / shrublands)
- Schweinfurt Training Area
  - 5,708 acres
  - Mixture of forest / non-forest vegetation with complex land ownership and management

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Remote Sensing Data

- Airborne Data Acquisition
  - High resolution airborne (multispectral and panchromatic) imagery – HRSC-A
    - Originally designed for NASA / DLR Mission to Mars
    - Automatic collection of multiple datasets, including:
      - Extremely high resolution panchromatic (black and white) imagery (16 cm resolution)
      - High resolution Digital Elevation Models (32 cm resolution)
      - High resolution multispectral (blue, green, red, near-infrared) data (50 cm resolution)
    - All data is automatically co-registered and georeferenced in real-time during the data collection

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HRSC-A Samples

Panchromatic (0.16m)
Berlin

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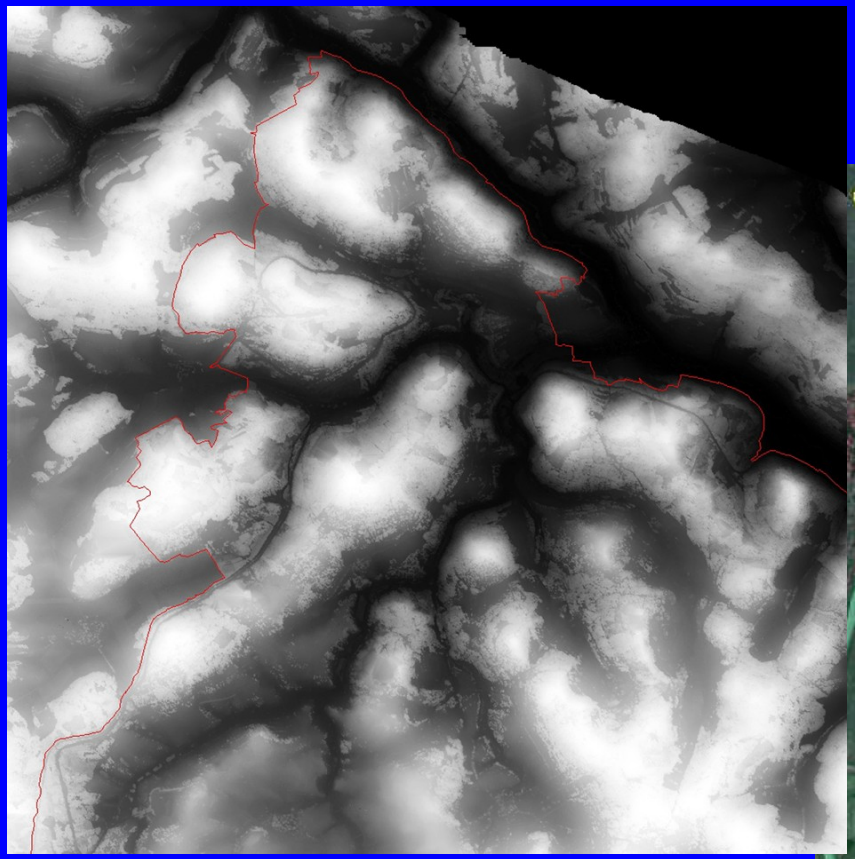
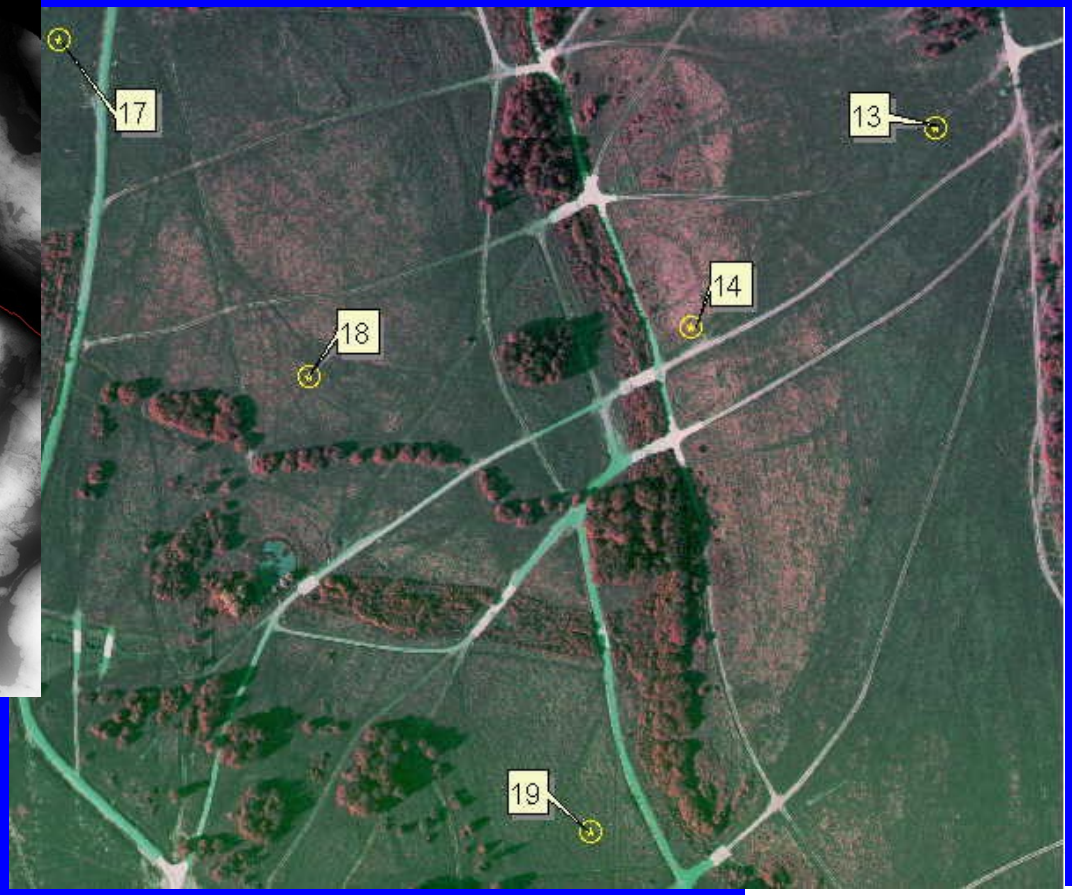
HRSC-A Samples



Digital Surface Model
Hohenfels

Multispectral (0.5m)
Friedberg



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Remote Sensing Data

- Airborne Data Acquisition
  - High resolution hyperspectral imagery – HyMap
    - Designed and operated by HyVista Corp. (Australia)
    - Spatial and spectral features of the data:
      - Typically flown for 3-5 meter resolution
      - Data is collected in a wide range of the EM spectrum (from blue to middle-infrared)
      - Data is collected in 128 discrete channels
    - Hyperspectral data can facilitate analysis that would not be possible with traditional types of remote sensing
      - i.e.: Comparison of spectral characteristics of ground objects with airborne / spaceborne measurements

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HyMap Samples

Rural (agricultural) area of Germany

Note the different representation of fields with various crops or bare soil, moisture levels, etc.

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HyMap Samples

Schweinfurt

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Vegetation Classification System

- National Vegetation Classification System (NVCS)
  - Developed by the Federal Geographic Data Committee and The Nature Conservancy with input from DoD and other Federal agencies
  - Benefit of providing repeatable, consistent standard for vegetation mapping on military lands
  - Used at a general level (the “Formation”) for this application. Would require adaptation to German vegetation conditions to map with more specific detail

NVCS Hierarchy and Examples

A. PHYSIOGNOMY

- **System** - Terrestrial/Aquatic - (hydrological regime)
  - **Class** - Woodland - (spacing & height of dominant form)
    - **Subclass** - Evergreen Woodland - (morphological & phenological similarity)
      - **Group** - Temperate Evergreen Needle-leaved - (climate latitude, growth form, leaf form)
      - **Formation** - Evergreen needle-leaved forest with conical crowns - (mappable units)

B. FLORISTICS

- **Alliance** (or cover type) - *Abies lasiocarpa* Forest (dominant species)
- **Association** (or community) - *Abies lasiocarpa/Vaccinium scoparium* [Subalpine fir/Grouseberry] (includes subdominant or associated plant species)

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NVCS Formations USAREUR Example

NVCS Value	Formation
IA8Nc	Conical-crowned temperate or subpolar needle-leaved evergreen closed tree canopy
IB2Na	Lowland or submontane cold-deciduous closed tree canopy
IIIB2Na	Temperate cold-deciduous shrubland
VA5Nd	Medium-tall bunch temperate or subpolar grassland
VC2Na	Permanently flooded temperate or subpolar hydromorphic rooted vegetation
VIIC4Cb	Non-agriculture disturbed areas
NV	Non-vegetated

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Image Classification Methods

- "Ground Truth" information
  - Aerial photography, other remote sensing datasets and LCTA data were used as the basis for locating ground truth plots (i.e.: locations of shrublands vs. grasslands, etc.)
  - GPS used to identify 20-50 point locations of plot centers for each of the training areas
  - Vegetation for each of these points was visually classified to the appropriate Formation, and notes about the vegetation in the surrounding area were recorded

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Image Classification Methods

- Image Processing
  - **Friedberg, Hohenfels and Schweinfurt:**
    - Multispectral HRSC-A data were statistically classified using “unsupervised” classification methodology
    - Initial classification results used to stratify imagery into major cover types (forest, non-forest, built-up, water)
    - Images containing only data from major cover types were re-classified using same process
    - Information from ground truth campaign was used to assist interpreters in labeling classes, i.e., assigning NVCS Formations to each spectral grouping in the classified images
  - **Grafenwoehr:**
    - Hyperspectral HyMap data was used, and statistically “compressed” prior to following the methods above

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Sample results for Grafenwoehr

Grafenwöhr Training Area				
NVCS Value	**Formation Description**	**Total Area (ac)**	**Percen tof Total Area**	**USLE C-Facto r**
IA8Nc	Needle-leaved evergreen	24012.34	42.7	0.019
IB2Na	Deciduous	4825.48	9	0.019
IIIB2Na	Deciduous shrubland	3972.53	7	0.017
VA5Nd	Medium-tall grassland	9780.22	17	0.099
VC2Na	Permanently flooded hydromorphic vegetation	188.19	0.3	0.000
VIIC4Cb	Non-agriculture disturbed areas	7106.96	13	0.257
NV	Non-vegetated	6401.80	11	0.000
Total		56287.51	100	

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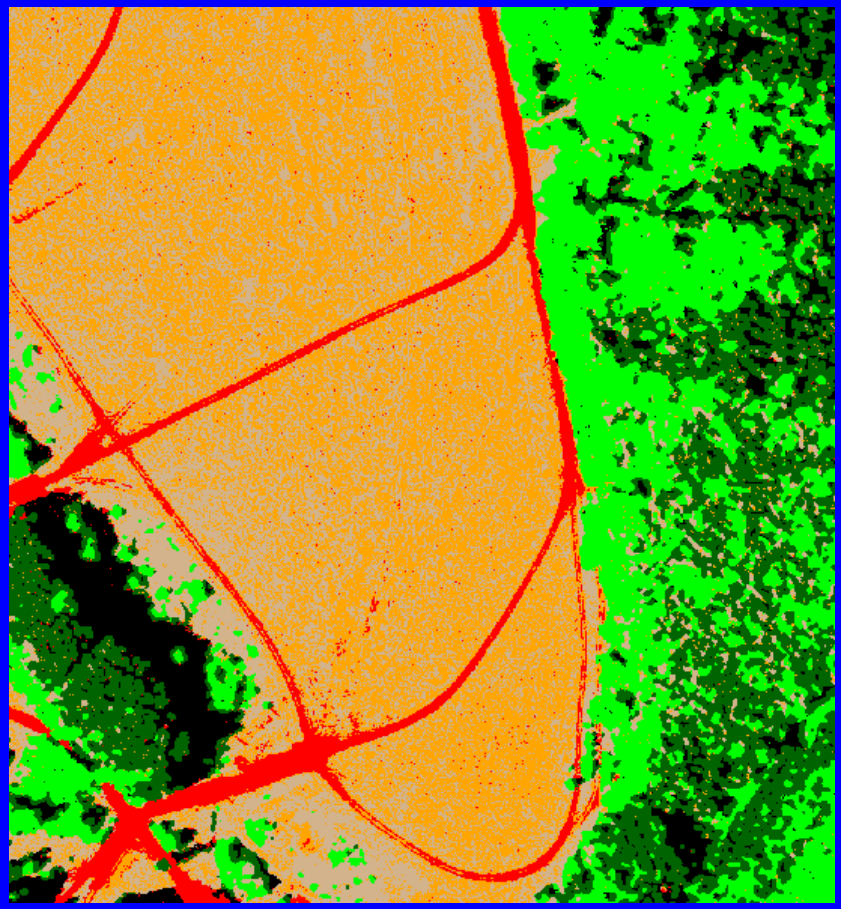
Sample Results



Schweinfurt

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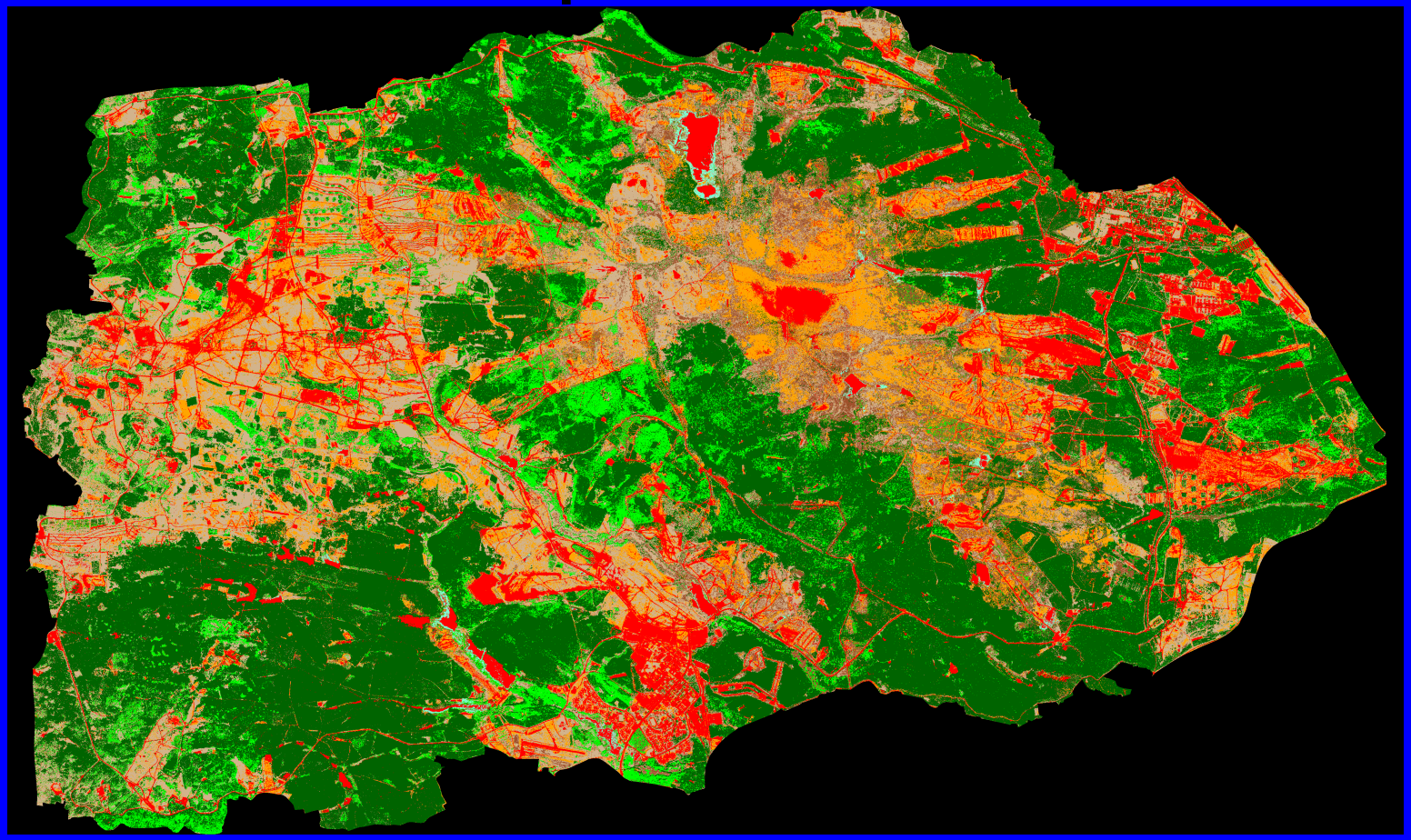
Sample Results



Grafenwoehr

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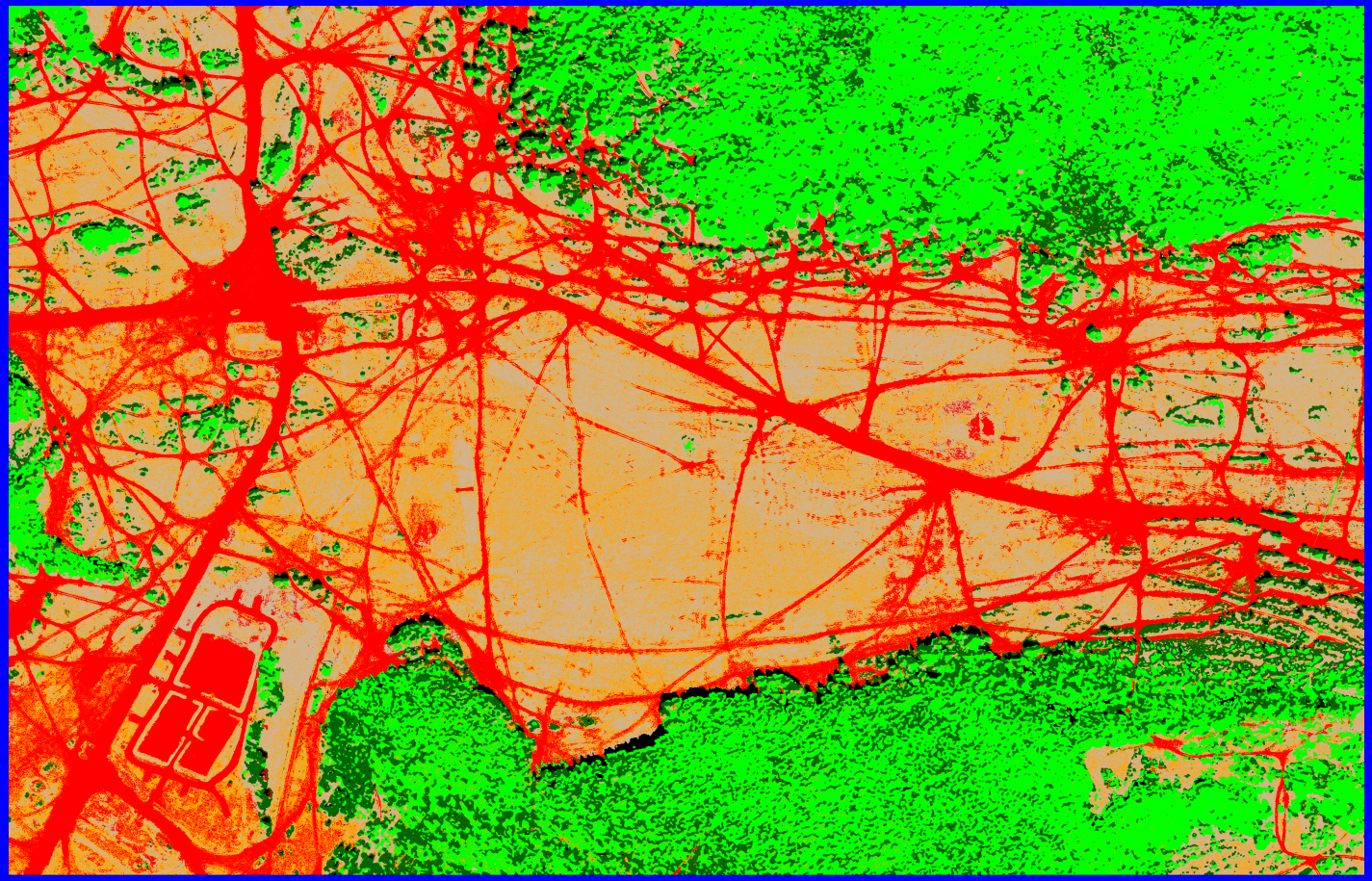
Sample Results



Hohenfels

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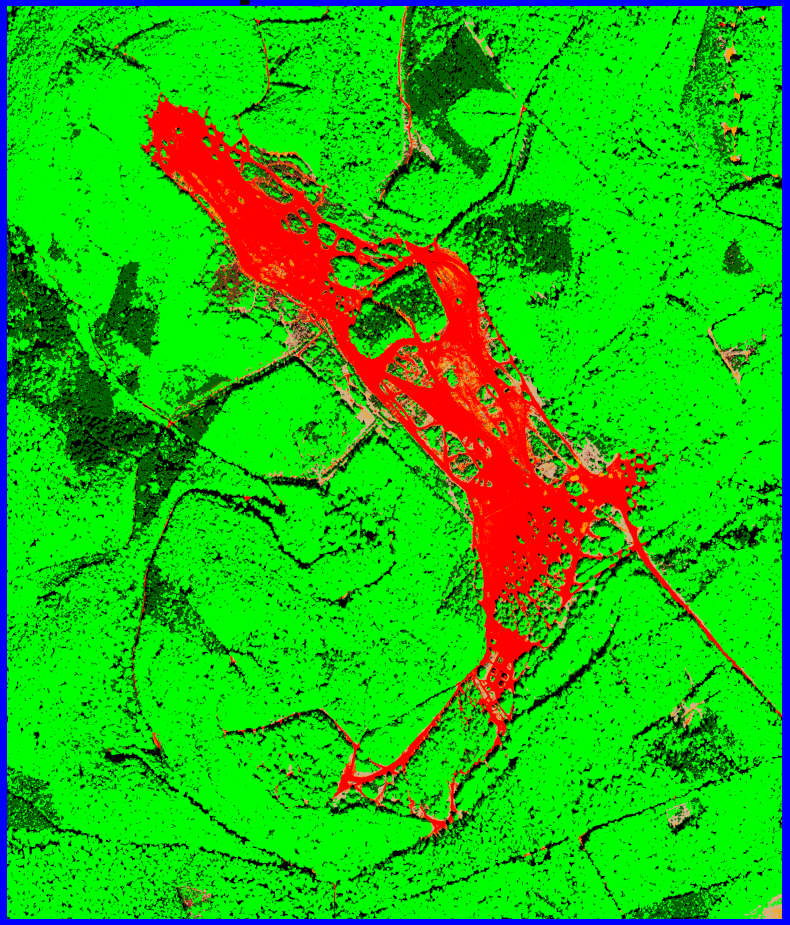
Sample Results



Friedberg

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Environmental Applications

- Monitoring of trends in vegetation condition and composition
- Biodiversity and Threatened and Endangered Species management and monitoring
- Erosion monitoring and modeling
- Realistic input for flyover simulations, etc.
- Identification of opportunities for further LCTA field surveys
- Development of training lands rotation to allow for vegetation recovery

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Training Applications

- Identification of training opportunities and/or off-limits areas
- Delineation of areas with trafficability issues due to soil conditions
- Mapping of compacted areas from heavy training
- Training sustainability studies / carrying capacity
- Long and short-term range development plans
- Planning of maneuver exercises with respect to concealment

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Summary

- Tradeoffs between airborne multispectral (high spatial resolution, low spectral resolution) and hyperspectral (high spectral resolution, lower spatial resolution)
- Use of standardized, hierarchical vegetation classification system
- Importance of ground data collection for the classification process
- Applications for high resolution vegetation maps are numerous

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